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# A Technical Approach to Groundwater Contamination Problems

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# A TECHNICAL APPROACH TO GROUNDWATER CONTAMINATION PROBLEMS

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## Abstract

Argonne National Laboratory has been performing technical investigations at sites in Nebraska and Kansas that have identified groundwater contamination by carbon tetrachloride. This comprehensive program will ultimately provide the affected communities with safe drinking water. The first step in the program is to evaluate the available data and identify sites that will require an Alternate Water Supply Study (AWSS). The objective of the AWSS is to identify options for providing a safe drinking water supply to all users, in compliance with the Safe Drinking Water Act. The AWSS consists of an engineering and cost evaluation followed by implementation of the selected alternatives. For sites with contamination less than a specific concentration, the AWSS is regarded as a satisfactory long-term solution, and no further action is taken. For those sites with concentrations above that specific limit, the AWSS implementation is regarded as only a stopgap measure, and the site is selected for additional remedial action. The first step of the remedial action is an Expedited Site Characterization (ESC). The ESC was developed at Argonne to decrease the cost and time of the remedial investigation and feasibility study while producing a high-quality technical investigation. The ESC is designed to characterize the contaminant plume configuration and movement, which requires an understanding of the geologic and hydrogeologic controls on groundwater movement as well as the nature and extent of any remaining carbon tetrachloride source in the soils. The ESC program uses a multidisciplinary technical approach that incorporates geology, geochemistry, geohydrology, and geophysics. Field activities include sampling, chemical analysis, and borehole and surface geophysical surveys. The last step of the program may involve the engineering design of a remediation system that will provide a long-term supply of safe drinking water to the affected community.

## Introduction/Background

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, requires that the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) develop a list of sites where releases or threatened releases of hazardous substances, pollutants, or contaminants may pose a risk to the public health or environment. That list is the National Priorities List (NPL). As of November of 1992, a total of 1,236 sites had been listed or proposed for listing on the NPL. The NCP sets forth guidelines and procedures needed to respond under CERCLA to the releases or threatened releases of hazardous substances, pollutants, or contaminants. The approach includes but is not limited to the following steps: remedial investigation/feasibility study (RI/FS), remedial design, remedial action, and operation and management of remedial systems.

The Environmental Protection Agency (EPA) has estimated the costs associated with these activities on the basis of the average total cost per site. These costs, in 1988 U. S. dollars, are presented below.

| Cost Category | Average Total Cost per Site ($) |
|---|---|
| RI/FS | 1,300,000 |
| Remedial design | 1,500,000 |
| Remedial action | 25,000,000 |
| Operation and management | 3,770,000 |

Not only are the activities costly, but the time estimates for completion of each phase of work are extremely long. (The RI/FS phase of the work can take more than two years, and the operation and management phase often requires the longest time). With the current methods of study and the time and money required to complete the work at any one NPL site, entire communities are left at continued risk from releases emanating from these sites.

Along with EPA, the Commodity Credit Corporation of the Department of Agriculture (USDA/CCC) has been actively involved with site characterization and groundwater cleanup activities under CERCLA at several sites in Nebraska and Kansas.

Carbon tetrachloride, the primary contaminant of concern, has been associated with past USDA/CCC grain storage operations at these sites. Early on, USDA/CCC recognized the need to address the reported groundwater problems in a timely manner to ensure the protection of public drinking water supplies, public health, and the environment.

On behalf of USDA/CCC, Argonne has developed a *Technical Action Plan* to address the impact of groundwater contamination at former grain storage facilities. According to this *Plan*, the first task is to conduct a study to determine whether an alternate water supply should be provided to affected communities. Specific guidelines based on the concentration levels of carbon tetrachloride have been set that determine if the alternate water supplies would be provided as a long-term response action or a short-term, temporary measure followed by an ESC. The ESC approach proposed and implemented by Argonne greatly decreases both the cost and time needed to characterize the contamination, thus decreasing the exposure risk to the public and the environment. Immediately upon completion of the ESC, decisions can be made as to the best method for providing the long-term supply of drinking water to the affected community. Simple solutions may be warranted in many cases where uncontaminated drinking water supplies are readily available to communities locally. If the results of the ESC support the need for aquifer restoration, the remedial design efforts can begin much more quickly than with standard site characterization methodologies.

## Alternate Water Supply Study

An AWSS is conducted when a community drinking water supply is reported to be contaminated with carbon tetrachloride above a specified concentration. The objective of the AWSS is to identify options for providing a safe drinking water supply to all users, in compliance with the Safe Drinking Water Act.

The AWSS includes engineering and cost evaluations and implementation of the selected alternative. If an adequate supply of potable water is available to meet the needs of the community, no further AWSS activities are warranted. Otherwise, the AWSS continues with the engineering and cost analyses of the alternate water supply options.

## Expedited Site Characterization

The ESC is a unique, cost- and time-effective, technically innovative methodology for site characterization developed by Argonne. The ESC determines the distribution of contamination within an aquifer, the general characteristics of an aquifer system, the nature and extent of any remaining source of soil contamination, and whether remedial action is necessary or feasible. The ESC approach revolves around a multidisciplinary, team approach to problem sc' ving. The basic features and steps of the ESC methodology are briefly discussed below.

A team of scientists with diverse expertise and strong field experience is required to make the process work. The Argonne team is composed of geologists, geochemists, geophysicists, hydrogeologists, chemists, biologists, computer scientists, health and safety personnel, and regulatory staff, as well as technical support staff. The technical team works together throughout the process. In other words, the team that plans the program also implements the program in the field and writes the reports.

The technical team first *critically* reviews and interprets existing data for the site and contaminants to determine which data sets are technically valid and can be used in initially designing the field program. One of the most basic mistakes in the site characterization process is failure to use technically sound available data to form working hypotheses on hydrogeology, contaminant distribution, etc. for initial testing.

After assembling and interpreting existing data for the site, the entire technical team visits the site to identify as a group the site characteristics that may prohibit or enhance any particular technological approach. Logistic and community constraints are also identified at this point.

After the field visit, the team selects a suite of technologies appropriate to the problem and completes the design of the field program. No one technique works well at all sites, and a suite of techniques is necessary to fully delineate site features. In addition, multiple technologies are employed to give greater confidence to conclusions about site features. Non-invasive and minimally invasive technologies are emphasized to minimize risk to the environment, the community, and the staff. Argonne has applied and developed several new innovative technologies for the process. In no case is the traditional approach of installation of a massive number of monitoring wells followed.

A *dynamic* work plan that outlines the program is produced for the sponsoring and regulatory agencies. The word dynamic is emphasized because the work plan is viewed as a guide, subject to modification, for the site characterization activity rather than a document that is absolute and unchangeable. Therefore, the health and safety plan and quality assurance/quality control plan must be broad and encompass all possible alterations to the work plan. The cooperation of the regulating agency is essential in successful implementation of this process.

The entire team participates in the technical field program. Several technical activities are undertaken simultaneously. These may range from different surface geophysics investigations to vegetation sampling. Data from the various activities are reduced and interpreted each day by the technical staff. Various computer programs are used to visualize and integrate the data. However, *people* do the data interpretation and integration, not the computers, which are just one more tool at the site.

At the end of the day, the staff members meet, review results, and modify the next day's program as necessary to optimize activities that are generating overlapping or confirming site details. Data are not arbitrarily discarded — each finding must be explained and understood. Anomalous readings may be due to equipment malfunctions, laboratory error, and/or the inability of a technique to work in a given setting even though theoretically it should.

The end result of this process is the optimization of the field activity to produce a high-quality technical product that is cost and time effective. When the ESC is concluded, the extent of the contaminant plume is defined, and the presence (or absence) of a soil source is verified. The ESC provides crucial information for the design and implementation of remedial technologies.

## Remedial Design and Implementation of Technology

The final step in this technical program is to provide a long-term alternate water supply to the affected community. This provision may be as simple as connecting the users of the affected water supply to a different source of public water that is not affected by the contamination, or it can involve the design and installation of a remedial system that will both halt the migration of the contaminated water from the site and restore the aquifer for future use as a source of drinking water.

Argonne provides oversight management for the engineering and implementation of the recommended remedial systems. Some remedial systems already implemented at former USDA/CCC site include groundwater extraction wells with air stripper and vapor extraction systems. The effectiveness of installing carbon filter systems in the water supply lines emanating from contaminated private drinking water wells is currently being evaluated.

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